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ENVIRONMENTAL CONTROL DISCUSSION DOCUMENT

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ENVIRONMENTAL CONTROL DISCUSSION DOCUMENT

by

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ABSTRACT

The Environmental Control Research Group of Coal Research Laboratories Surface Mining Laboratory will start functioning from Devon, Alberta effective July 1986. This document describes the projects that this group intends to pursue. The conduct of these proposed projects is dependent upon industry support and the outputs will be evaluated in terms of relevance to industry needs.

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DOCUMENT SCIENTIFIQUE PORTANT SUR LE CONTRÔLE ENVIRONNEMENTAL

par

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RÉSUMÉ

Le groupe de recherche sur le contrôle environnemental du Laboratoire de recherche sur l'exploitation à ciel ouvert des Laboratoires de recherche sur le charbon entreprendra ses activités à partir de Devon (Alberta) à compter de juillet 1986. Le présent rapport comprend une description des projets que ce groupe entend réaliser. La réalisation des projets proposés dépend du soutien que fournira l'industrie et le résultats seront évalués en fonction des besoins de l'industrie.

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INTRODUCTION

The activities of the Environmental Control group can be divided into three main projects namely spontaneous combustion, methane control and environmental monitoring. However, during the next five years the major thrust is proposed to be in the area of spontaneous combustion.

The CANMET resources alloted to this activity are 1.2 person years professional time and 0.5 person years technician time. In view of limited in house resources part of this activity will be carried out through research contracts awarded to private sector performers.

SPONTANEOUS COMBUSTION

Spontaneous combustion has always been recognized as a major problem both from safety aspects and from economic considerations. In the light of serious fires and explosions that have occurred in recent years there has been renewed interest to direct R & D efforts in this area.

In a time of over supply, if costs and quality are comparable, users will opt for coal purchases from suppliers who can deliver products with a minimum of handling problems. Spontaneous combustion incidents can prejudice reliability of supply and also highlights the need for special handling requirements.

Our goal is to provide world class technology for prediction and control of spontaneous combustion to the Canadian coal industry to assist them in their effort to remain competitive in the export thermal coal market. This can be best achieved through a comprehensive R & D program with industry collaboration.

Coal Characterization

Currently there is no simple method which can be used to predict whether mining of a coal seam will result in spontaneous combustion. However knowledge of the relative potential of coal to oxidize is a useful tool for mine planning. This parameter can be used for evaluating the precautions necessary during mining, transportation and storage and can indicate the potential fire hazard of a seam or sections of a seam during mining.

Recently laboratory facilities were established for characterization of Canadian coals with respects to their susceptibility to spontaneous combustion using the following parameters:

a) Relative ignition or crossing point temperature

b) Oxygen absorption under static isothermal condition

c) Nature of gases emitted during low temperature oxidation of coal.

The crossing point temperature experimental parameters were defined using low rank thermal coals. Subsequently tests were completed on a number of western Canadian coals. The test results proved encouraging. A high heating rate and low crossing point temperature indicate that the coal is more liable to spontaneous heating. Liability index calculated as the ratio of heating rate and ignition temperature proved useful in effectively characterizing different coals. In general, thermal coals appear to be more susceptible to spontaneous combustion when compared to metallurgical coals. The tests further showed that thermal coals from the foothills region are more liable to spontaneous combustion when compared to thermal coals obtained from the plains region of Alberta. An interim report summarizing these results has been completed. Further work with additional coals is now in progress, and it is planned to continue this work till 1988-89 so that most of the major coal fields in Canada can be covered.

An evaluation of the laboratory methods used to date to determine relative susceptibility to spontaneous combustion for different coals shows that it is impossible to simulate all the environmental conditions existing in an operating mine or in a coal storage silo. Research so far has used tests which are empirical in nature. It is proposed to develop a computer controlled automated multi-sample test apparatus for carrying out spontaneous combustion susceptibility tests suitable for Canadian coals.

Development of this apparatus will help in carrying out tests more accurately for a large number of samples with site specific constraints on short notice and will prove to be a valuable aid to the coal mining industry. The first phase of the work is expected to start towards the middle of 1986. The test apparatus is expected to be completed by March 1989.

Early Detection of Heating

The early detection of fire is of prime importance to mine operators. Any fire which can be detected at an early stage may save the facility from considerable upset and damage. This has made it imperative to develop systems suitable for early detection of heating.

Research world wide during the past decade has made significant progress in this area. CANMET initatives have resulted in the development of two generations of continuous monitoring systems for early detection of heating. The tube bundle system for monitoring carbon monoxide was installed and operated in the hydraulic mine at Westar Mining Ltd., for a number of years starting in 1976. In spite of some initial difficulties the system proved useful for the detection of heating and to ensure safer working environment. In early 1984 a continuous monitoring system based on telemetry using carbon monoxide, methane and airflow sensors was installed in the same mine for performance evaluation. The system operated till the mine was closed in January 1985.

The continuous monitoring of carbon monoxide appears to be the most practical method for the early detection of heating. However, the monitoring strategy for coal silos will have to be worked out to make the method effective. CANMET is presently assisting two coal mine operators in their efforts to monitor gases in their coal silos for early detection of heating.

CANMET's work in recent years indicated that infra-red scanners and thermometers can be used sucessfully in locating hot spots in coal stacks and in underground coal mines. The infra-red instruments are portable easy to use and capable of remote measurement thus eliminating the complex instrumentation needed for the operation of thermistors and thermocouples.

Infra-red imagers can present a detailed thermal picture of the entire scene within the view of the instrument showing temperature differences between closely placed objects and between objects and background. It is thus possible to locate hot spots in a large body with remarkable speed and accuracy.

In recent years considerable progress has been made in infra-red technology by introducing video convenience and computer based interpretation of the thermal picture. Image handling is greatly simplified. The computer can draw trends, calculate rate of temperature increase and includes many other options for the presentation of data. Results obtained during field surveys can be analysed in the laboratory and where necessary the micro computer is interfaced with a mini computer for even more complex image analysis. Success of this technique depends largely on correct interpretation of thermal images. R & D work using this advanced technology will undoubtedly prove beneficial in our attempts towards successful detection of heating in coal mine operations particularly during storage and handling of coals. New developments in Canada and abroad should be monitored, evaluated and demonstrated to ensure best available technology for operators. R & D work in this area should continue so that state of the art expertise is available for industry.

Spontaneous Combustion Problem Associated with Drying of Coal

Handling of partially dried thermal coal (high volatile bituminous/ sub-bituminous) has become a major concern to coal mine operators. Studies so far have indicated that coals which have a high equilibrium moisture content when dried becomes extremely susceptible to spontaneous combustion. Laboratory studies have also shown that there can be a substantial temperature rise when partially dried coal samples are treated with moist air. The temperature rise is also significant even when moist nitrogen is passed on dried coal confirming that heat of wetting plays a major role in early stages of spontaneous combustion. An in-depth study on the effect of reduction of inherent moisture content towards spontaneous combustion susceptibility is proposed. The objective would be to optimize the inherent moisture content during drying process particularly with the low rank coals for storage and transportation so as to reduce hazards from spontaneous combustion. It is proposed to continue this work through contract R & D.

Inerting as a Control Measure to Prevent Spontaneous Combustion

In recent years inerting the gob area proved valuable in preventing spontaneous combustion in coal seams highly susceptible to heating. Application of this technology is likely to help in reducing fires during storage and handling of thermal coal. Effective utilization of this technology will require considerable R & D effort and CANMET is willing to initiate such studies with industry collaboration.

METHANE CONTROL

Effective control of methane during mining, storage and transportation is considered essential for the safe handling of coal. Hazardous concentration of methane in coal silos have caused several serious explosions in Canada in the recent past. At least three explosions have also occurred in shipholds carrying coals from eastern Canada during the last five years.

Explosions of methane in silos and coal ships is an ever present hazard. Recent investigations have shown beyond question that considerable accumulations of methane do occur in coal storage silos and numerous recent explosions in coal transport shipping strongly indicates that the same conditions also exist in ship storage holds. Investigations have shown that the main concentrations of methane occur within the actual coal pile. Consequently ventilation is not an effective method for removing the methane. The main line of defence is therefore to exclude potential sources of ignition or to place the coal in an inert atmosphere, or both.

Investigations will continue to search for better methods to implement both of these principles. CANMET through contract R & D has initiated work on biological control of methane as a rather unconventional technique for methane control in coal storage silos and ship holds. Transport Canada's, Ship Safety division, who has a very real interest in this project is providing significant financial assistance to this project.

A review of scientific literature indicated that micro biological control of methane is feasible. Methane oxidizing bacteria were isolated from a number of coal samples collected from Canadian mining operations. Laboratory studies have shown that these microrganism can remain active over an extended period and the rate of methane oxidation is quite appreciable.

Small laboratory scale experiments were successfully scaled up to allow 10 kg of coal to be tested in a model silo and rates of methane oxidation was found to be equally effective. The organisms were found particularly active with western Canadian coals with low sulphur contents. Modified procedure resulted in growing bacteria culture which are suitable for high sulpher coals and test results using washed Cape Breton Coal were quite encouraging.

Work is underway with a model silo using 2-3 tons of coal. The samples tested will include coals from both western and eastern Canada. R & D work will be needed to produce methane oxidizing bacteria on a large scale at low cost. Recently CBDC management in Nova Scotia expressed their interest in this novel technique and agreed to provide financial support to this project. They have also agreed to provide all facilities needed during commercial testing proposed for 1987-88.

ENVIRONMENTAL MONITORING

Evaluation of the Conspec environmental monitoring system developed by a Canadian manufacturer has now been completed. The project provided valuable experience to the Canadian manufacturer, the mine management and to CANMET personnel and helped in resolving most of the problems encountered with this newly developed system. A divisional report summarizing this experience along with the recommendations resulting from the field testing is available.

In western Canada there is now only one operational underground coal mine. Therefore the demand for this type of environmental monitoring system is correspondingly diminished. Hence, no further testing of this type of systems is envisaged in the near future for underground coal mines in western Canada.

AOSTRA-CANMET Cooperative Project on Environmental Monitoring

In the past CANMET has provided assistance in the monitoring of gases emitted during the drivage of the Saline Creek Tunnel at Fort McMurray using the tube bundle technique. As the tunnel was driven through the tar sand formation close to the surface, very little entrained gases were noticed. A CANMET report summarizing these results is also available.

AOSTRA in consultation with this Laboratory installed a comprehensive mine monitoring system for the Underground Test Facility (UTF) near Fort McMurray, Alberta. After a number of joint meeting it was decided that the tube bundle system based on available technology would be most suitable for monitoring of the underground environment. This Laboratory worked jointly with AOSTRA in determining the monitoring strategy. A work plan was prepared and was accepted by AOSTRA. Advice was given on a continued basis during selection of monitoring equipment for this project. Laboratory staff will continue to provide technical expertise and assist in interpreting results for AOSTRA .

EMERGENCY SERVICES FOR EXPLOSION AND FIRE

The possible occurrence of explosions, fires and heatings in the coal mining industry is an ever present hazard. In recent years these incidents have caused considerable damage to mine plant equipment, loss of production and threatened the safety of the work force. There exists instrumentation that can measure the gases and heat produced by combustion and can detect any potentially explosive accumulation of gases. CANMET, Surface Mining Research Laboratory has personnel experienced in the use of this instrumentation and in the interpretation of their results. Such personnel and instrumentation would be capable of detecting and evaluating locations that are susceptible to fire, heating or explosion in order that remedial actions can be taken. This capability could also be used to determine the extent of an existing fire or heating or the cause of an explosion.

It is proposed that CANMET establish a Fire Analysis Facility equipped with appropriate portable instrumentation to advise the mining industry on fire, explosions and heating hazards and possible remedial actions. This group will be set up primarily as a service to the industry and would operate on a cost recovery basis. The group will ensure a fast response to requests for assistance by industry to situations that may be aggravated by delay. The formation of this group is dependent on the favorable response of industry and provincial inspectorates and the availability of money to purchase the required instrumentation ($120K).

MAJOR WORK PLAN/OUTPUT

1. Prepare a comprehensive report on the characterization of Canadian coals with respect to their susceptibility to spontaneous combustion.
   (In house & Industry) Completion date: 1989-90

2. Design and develop a multi sample automated state of the art apparatus for rapid evaluation of spontaneous combustion susceptibility for Canadian coals.
   (In house & Contract R & D) Completion date: 1989-90

3. Develop suitable strategy for early detection of heating in coal storage silos and coal stockpiles using newly developed infra-red thermography and automated gas monitoring.
   (In house & Industry) Completion date: 1988-89

4. Prepare a comprehensive report discussing in detail the effect of drying on spontaneous combustion characteristics of thermal coals. Recommend measures for partially dried thermal coals during storage and transportation to reduce hazards caused by spontaneous combustion.
   (In house & Contract R & D) Completion date: 1990-91

5. Prepare guidelines for safe storage of coals in silos to reduce the hazards caused by emission and accumulation of methane.
   (Contract R & D & Industry) Completion date: 1988-89

6. Assist in developing technology needed for biological control of methane for full scale application taking into consideration the operating conditions in coal storage silos and ship holds.
   (Contract R & D & Industry) Completion date: 1990-91

CONCLUDING REMARKS

This document describes the Environmental Control group's proposed work plan. It is ambitious given the assigned resources. Consequently it will be necessary to respond to the needs of industry and concentrate on those research projects that receive strong and enthusiastic industry support. In order to determine the most relevant directions that the Environmental Group should follow it is requested that industry indicate whether they are interested in supporting or collaborating on any of the elements proposed in the work plan. Alternatives to the proposed work plan that meet industry needs are also welcome.

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